

American Computer Science League

2023-2024 • Contest 1: Short Problems Solutions • Junior Division

1. Computer Number Systems $\begin{aligned}2324_{10} &= 4 * 8^3 + 4 * 8^2 + 2 * 8^1 + 4 * 8^0 \\&= 4 * 512 + 4 * 64 + 2 * 8 + 4 \\&= 4424_8\end{aligned}$	D. 4424
2. Computer Number Systems $\begin{aligned}73452_8 - 4261_8 + 752_8 \\&= (73452_8 - 4261_8) + 752_8 \\&= 67171_8 + 752_8 \\&= 70143_8 \\70143_8 &= 111\ 000\ 001\ 100\ 011_2 \\&= 111\ 0000\ 0110\ 0011_2 \\&= \begin{array}{cccc}7 & 0 & 6 & 3\end{array}_{16}\end{aligned}$	C. 7063
3. Recursive Functions $\begin{aligned}f(22) &= f(22 - 4) + 1 = f(18) + 1 = 17 + 1 = 18 \\f(18) &= f(18 - 4) + 1 = f(14) + 1 = 16 + 1 = 17 \\f(14) &= f(14 - 4) + 1 = f(10) + 1 = 15 + 1 = 16 \\f(10) &= 2 * f(10 + 1) - 3 = 2 * f(11) - 3 = 2 * 9 - 3 = 15 \\f(11) &= 2 * f(11 + 1) - 3 = 2 * f(12) - 3 = 2 * 6 - 3 = 9 \\f(12) &= f(12 - 4) + 1 = f(8) + 1 = 5 + 1 = 6 \\f(8) &= 8 - 3 = 5\end{aligned}$ <p>Now substitute backwards.</p>	E. 18
4. Recursive Functions $\begin{aligned}f(24) &= f(24/2) + 4 = f(12) + 4 = 15 + 4 = 19 \\f(12) &= f(12/2) + 4 = f(6) + 4 = 11 + 4 = 15 \\f(6) &= f(6/2) + 4 = f(3) + 4 = 7 + 4 = 11 \\f(3) &= f(3 - 1) + 2 = f(2) + 4 = 5 + 2 = 7 \\f(2) &= f(2/2) + 4 = f(1) + 4 = 1 + 4 = 5 \\f(1) &= 1\end{aligned}$ <p>So $f(f(24)) = f(19) = 15$</p> $\begin{aligned}f(19) &= f(19 - 1) + 2 = f(18) + 2 = 13 + 2 = 15 \\f(18) &= f(18/2) + 4 = f(9) + 4 = 9 + 4 = 13 \\f(9) &= 9\end{aligned}$	C. 15

5. What Does This Program Do? (Branching)

Each of the choices calculates the value of pay. However, the results are not always the same.

- a) if $\text{hrs} > 40$, the overtime hours are paid twice
- b) all of the hours are paid first then half is added for the overtime hours
- c) it is the same as letter b, but done with two separate statements
- d) if $\text{hrs} < 40$, they will get paid for 40 hours

Therefore, both b and c calculate it correctly no matter what.

E. b, c
